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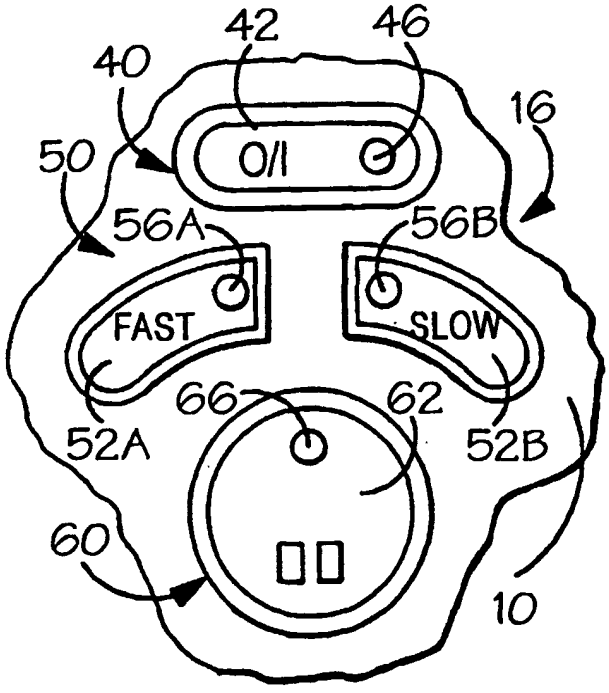
(54) Title: APPLIANCE USER INTERFACE



(57) Abstract: A robotic appliance (10) has a user interface (16) for controlling the appliance. The interface (16) comprises a plurality of user controls (40, 50, 60), each control having an indicator (46, 56A, 56B, 66) closely visibly associated with it. Each control indicator (46, 56A, 56B, 66) is able to provide three different visible states. The visible states are (a) an off state indicative that the associated control is not available for selection, (b) an invitation to operate state indicative that the associated control is available for selection and (c) a selected state indicative of the associated control being selected. The invitation to operate state (b) can be represented by flashing the indicator. The user interface illuminates one of the control indicators in visible state (b) and, in response to a user operating that control, changes the visible state of the control indicator to visible state (c) and illuminates another of the control indicators in visible state (b) whereby to indicate a change in the state of readiness-for-use of the appliance and to guide a user through the start-up procedure.

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Appliance User Interface

This invention relates to a user interface arrangement for controlling a robotic appliance, particularly but not exclusively to a robotic floor cleaning device such as a vacuum cleaner.

Appliances usually have some form of user interface comprising a number of controls which a user can operate to control the appliance. A user may need to operate several of the controls before the appliance can begin operating, and the controls may offer the user a choice of values for a particular variable. This can be confusing for a user. A user interface for a clothes dryer is shown in US 4,372,054 where a control panel is divided into a plurality of sections, which are sequentially illuminated as a user makes their selections.

The present invention seeks to provide a user interface which is more convenient to operate.

Accordingly, a first aspect of the present invention provides a user interface for a robotic appliance by which a user can control the appliance, the interface comprising a plurality of user-operable controls grouped together, each control having a respective indicator closely visibly associated with it, each control indicator able to provide three different visible states, the visible states being (a) an off state indicative that the associated control is not available for selection, (b) an invitation to operate state indicative that the associated control is available for selection and (c) a selected state indicative of the associated control having been selected, the user interface being arranged to illuminate one of the control indicators in visible state (b) and, in response to a user operating that control, to change the visible state of the control indicator to visible state (c) and to illuminate another of the control indicators in visible state (b) whereby to indicate a change in the state of readiness-for-use of the appliance.

The interface has the advantage that it is easier to use by providing a visible indication of the functions available to the user at any particular time. Also, the interface invites the user to operate the plurality of controls in a defined or preferred sequence, thus guiding the user through the controls. The selected state of the indicators displays to the user previously made selections of the available controls; for example, a selection of speed (fast or slow) or of the brush bar (on or off).

Preferably the invitation to operate state is represented by an on/off sequence, i.e. flashing, which clearly indicates to a user which of the plurality of controls needs to operated next. Where a control has two or more buttons, each with their own indicator, both of the indicators are illuminated. A control having two or more buttons can be one offering a selection of speed options (fast, slow) for the appliance.

Preferably the first of the control indicators is illuminated by an on/off sequence having a mark/space ratio much less than unity. This can provide a sharp pulse of light which does not consume any significant quantity of power and yet indicates to the user that the appliance is ready to be activated. Such a visible state can be maintained for significant periods of time.

Preferably, the second control indicator is also a light source and the visible state (b) also comprises an on/off sequence but having a mark/space ratio at or close to unity. This provides a clear signal to the user that the appliance requires operation of the second control before it can become operational.

Preferably the appliance comprises means for detecting the presence of a power source connected to the appliance and the first stage of readiness-for-use is indicated in response to detecting the presence of the power source. For a robotic appliance this can be an onboard battery power supply.

Preferably, the second stage of readiness-for-use includes connecting an onboard processor in the appliance to the power source.

A second aspect of the invention provides a method of operating a robotic appliance

Further advantageous features are set out in the subsidiary claims.

An embodiment of the invention will now be described with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a robotic vacuum cleaner having a user interface according to an embodiment of the present invention;

Figure 2 is a circuit diagram of a power management system, navigation system and user interface arrangement for the robotic cleaning device shown in Figure 1;

Figure 3 shows one particular physical arrangement of the user interface of the cleaner of Figures 1 and 2;

Figure 4 is a circuit diagram, shown in greater detail, of the user interface arrangement; and

Figure 5 is a global indication state diagram of the indicators in the various stages of readiness of the appliances.

Referring firstly to Figure 1 of the drawings, there is shown a robotic floor cleaning device in the form of a robotic vacuum cleaner comprising a main body 10, two drive wheels 11, a brush bar housing 12, two rechargeable batteries 13 and 14, a cyclonic separator 15 of the type more fully described in EP-A-0 042 723, a user interface arrangement 16, a light detector 17 and various sensors 27 to 31 which are used to guide

the cleaner. The light detector 17 detects light received from a plurality of compass points around the vacuum cleaner and is more particularly described in our copending International Patent Application No PCT/GB 99/04092. Other forms of separator such as a bag can be used in place of the cyclonic separator 15.

The circuit shown in Figure 2 comprises the two rechargeable batteries 13 and 14, a battery and motor management system 18, a motor 19 for driving a suction fan, motors 20 and 21 for driving the left and right hand wheels 11 of the vacuum cleaner, a motor 22 for driving a brush bar of the vacuum cleaner, processing circuitry 23 (which includes a microprocessor and field programmable gate arrays), a user interface board 26 and the light detector 17.

The robotic vacuum cleaner is also equipped with a plurality of infrared transmitters and receivers 27, a plurality of ultrasonic transmitters and receivers 28 and 29, threshold detectors 30 for detecting the presence of a portable threshold locator placed, for example, at the entrance to a room or at the edge of a staircase, and one or more pyro electric (passive infrared) detectors 31 for detecting animals and fires.

Referring now to Figures 3 and 4, the user interface 16 comprises three controls 40, 50 and 60, grouped together. The first and third controls are each in the form of a single push-button 42, 62 which closes a switch contact 44, 64 upon operation by a user. Control 40 is an on/off button and control 60 selects "go" or "pause".

The second control 50 comprises two separate buttons 52A, 52B, each of which closes a switch contact 54A, 54B upon operation by a user. Button 52A selects a fast speed of operation of the cleaner and button 52B selects a slow speed of operation of the cleaner.

Each button 42, 52A, 52B, 62 has visually closely associated with it an indicator. In this embodiment, each indicator comprises a single light emitting diode 46, 56A, 56B and 66, respectively, mounted on each button 42, 52A, 52B, 62. Alternatively, the indicator

could be placed next to the appropriate button 42, 52A, 52B, 62 and supported on the body 10, provided only that the indicator is visually closely associated with its respective control. The first control 40 is logically separate from the other controls 50, 60 and is connected to the battery management system via the user interface board 26 but does not pass through the FPGA, as shown in Figure 4. Each of the remaining controls 50, 60 and their respective light emitting diodes 56A, 56B, 66 is connected directly to the FPGA or the user interface board 26. The arrangement is such that operation of one or other of the buttons 42, 52A, 52B, 62 can cause the respective light emitting diode 46, 56A, 56B, 66 to change its visible state. The visible states which can be adopted by each light emitting diode 46, 56A, 56B, 66 are on (i.e. continuously illuminated), off (i.e. not illuminated) and flashing on and off. The user interface board sets the visible state of each light emitting diode 46, 56A, 56B, 66 in response to user operation of the buttons 42, 52A, 52B, 62.

The operation of the specific embodiment of the user interface will now be described. When the batteries 13 and 14 have been charged and plugged into the cleaner, the battery management system 18 detects this (i.e. that the batteries 13, 14 are present and that they are charged). In an alternative arrangement (not shown), the batteries 13, 14 could be charged in-situ on the cleaner. When it has been confirmed that the charged batteries 13, 14 are present, the light emitting diode 46 associated with the first control 40 is put into a first visible state (a) representative of a first stage of readiness-for-use of the cleaner. The first visible state (a) for the light emitting diode 46 is an on/off pulse sequence having a mark/space ratio much less than unity, e.g. 1:100. At this point the processor circuitry 23 has not been connected and the indicators 56A, 56B and 66 are off. If the user wants to use the machine, the flashing indicator 46 invites the user to operate the first control 40 by pressing the button 42.

The global indication state, i.e. the combined state of indicators 46, 56A, 56B and 66, is represented schematically in column A of Figure 5.

On operation of the control 40, the contacts 44 are closed and the battery management system 18 connects the processor circuitry 23 to power it up. The battery management system then tells the light emitting diode 46 to adopt a visible state which consists of continuous illumination, i.e. the indicator remains on. Thus the visible state (a) of the light emitting diode 46 disappears and changes to a different state (b), continuous illumination. This tells the user that the first control 40 has been operated.

The cleaner is now in a more advanced state of readiness-to-run as it has charged batteries 13, 14 on board and its processor 23 is powered up. The processor 23 will check the integrity of many aspects of the cleaner and, consequent upon that check being successful, will energize the light emitting diodes 56A, 56B of the second control 50 to flash on and off, through pulse width modulators PWM, with a mark/space ratio of or close to unity. This constitutes visible state (b) for the light emitting diodes 56A, 56B of the second control 50 and invites the user to operate the second control 50 to take the cleaner to a more advanced state of readiness-for-use. The global indication state, i.e. the combined state of the indicators, is represented schematically by column B in Figure 5.

The user is invited to operate the second control 50 next, in preference to any other, because it is flashing on and off whereas the other controls 40, 60 have light emitting diodes which are either continuously on or continuously off. The processor 23 senses the state of the contacts 52A, 52B through the FPGA on the user interface board 26. Buttons 52A and 52B allow the user to select either a fast or slow mode of operation of the cleaner, depending upon requirements. In slow mode, the cleaner will clean better but will take longer. In fast mode, the cleaner will complete the task more quickly but may not clean so thoroughly on the same floor. The selection of either button 52A or 52B will tell the processor 23 to select the required motor speed for the driving wheel motors (the speed of the brush bar will not change – it is the same for either selection).

When the appropriate button 52A or 52B is pressed (either fast or slow), the appropriate contacts 54A or 54B will close thereby instructing the processor 23 via the FPGA and the PWM circuit to change the flashing visible state of the associated light emitting diode 56A or 56B to a visible state in which the light emitting diode is continuously energised. The previously adopted flashing state, visible state (b), disappears. The fast or slow button indicator 56A or 56B, whichever was chosen, will then remain illuminated continuously. The other one of the fast and slow button indicators 56A, 56B, i.e. the one which was not selected, is instructed by the processor 23 via the user interface board 26 to change the visible state to "off" so that it is no longer energized. This tells the user which speed of operation has been selected, and also that a selection has taken place. The cleaner is therefore in a more advanced state of readiness-for-use than it was before the second control 50 had been operated because the cleaner knows at which speed it is required to operate. At the same time as the light emitting diodes 56A, 56B are changed from visible state (b) to an alternative visible state, the processor 23 energizes light emitting diode 66 to have an on/off sequence with a mark/space ratio of around unity. The global indication state of the indicators 46, 56A, 56B and 66 is now represented by column C in Figure 5. This invites the user to operate the third control 60 next, in preference to any other, because its indicator is flashing on and off whereas the others are continuously on.

The cleaner is now in a final state of readiness-for-use and all that is left is for the user to press the third control button 62 to instruct the cleaner to begin its cleaning task. When the button 62 is pressed, the light emitting diode 66 changes from its first visible state, continuously flashing, to a second visible state, continuously on. This tells the user that the button 62 has been pressed and that the sequence of operation of the controls 40, 50, 60 is complete. The global indication state of the indicators is now represented schematically by column D in Figure 5.

At any time during autonomous cleaning, it is possible for the user to press the go/pause button 62 to pause the cleaner. The associated indicator 66 will then change its visible

state and revert to flashing on and off as before. This invites the user to press the button 62 again in order that cleaning can be resumed. Also the option of changing the speed will become possible by pressing the appropriate button 52A, 52B of the second control 50. When the third button 62 is pressed, the flashing of the light emitting diode 66 stops and it remains continuously illuminated.

It can be seen from Figures 3 and 5 that the grouping together of the user controls 40, 50 and 60 and the global indicator states A, B and C, invites the user to operate one of the controls by making the indicator associated with that control visually distinctive within the group, and that operation of that visually distinctive control changes the global indication state and enters a new global state in which another control indicator is rendered visually distinctive within the group.

The invention is not intended to be limited to the precise details of the embodiment described above. Other physical button arrangements are possible and other forms of indicator are also possible. For example, the colour of the light emitted by the light emitting diodes could be arranged to change in order to indicate a change of visible state. In such a case, each light emitting diode could be caused to change from red to green on operation of the associated button, so that a red light constitutes a first visible state and a green light constitutes a second visible state. In the global state schematic of Figure 5 then, the flashing state would be replaced by a continuous red light and the on state would, instead, be represented by a continuous green light. Off would be unchanged. Thus a change of state would be a change of colour. In another embodiment the visible states could be off, bright and dim, the bright state replacing the flashing state and the dim state replacing the continuously lit state in the first-discussed embodiment.

The dual-speed option described with reference to buttons 52A and 52B is not essential to this invention. These buttons could be omitted altogether on a simpler machine which had no speed option and therefore only one available speed. Alternatively, the

arrangement could be more complex with, for example, three speed options: fast, medium and slow. Then again, there could be a further option in which the user is able to select whether or not the brush bar is to operate during cleaning. For example, on a smooth kitchen or utility room floor with no carpet, operation of the brush bar may add little benefit to the performance of the cleaner. Activation or otherwise of the brush bar could be an option to be selected either before or after the choice of speed. Other optional modes of operation are equally feasible.

Claims

1. A user interface for a robotic appliance by which a user can control the appliance, the interface comprising a plurality of user-operable controls grouped together, each control having a respective indicator closely visibly associated with it, each control indicator able to provide three different visible states, the visible states being (a) an off state indicative that the associated control is not available for selection, (b) an invitation to operate state indicative that the associated control is available for selection and (c) a selected state indicative of the associated control having been selected, the user interface being arranged to illuminate one of the control indicators in visible state (b) and, in response to a user operating that control, to change the visible state of the control indicator to visible state (c) and to illuminate another of the control indicators in visible state (b) whereby to indicate a change in the state of readiness-for-use of the appliance.

2. A user interface according to claim 1 wherein the invitation to operate state (b) is represented by an on/off sequence and the selected state (c) by steady illumination.

3. A user interface according to claim 2 wherein there is a first control and indicator and a second control and indicator which are operable in that order, the invitation to operate state (b) of the first indicator being represented by an on/off sequence having a smaller mark/space ratio than the invitation to operate state (b) of the second indicator.

4. A user interface according to claim 3 wherein the invitation to operate state (b) of the first control indicator is represented by an on/off sequence having a mark/space ratio much less than unity.

5. A user interface according to claim 3 or 4 wherein the invitation to operate state (b) of the second control indicator is represented by an on/off sequence having a mark/space ratio at or close to unity.

6. A user interface according to any one of the preceding claims comprising means for detecting the presence of a power source connected to the appliance and wherein a first control is illuminated in the invitation to operate state (b) in response to detecting the presence of the power source.

7. A user interface according to claim 6 wherein the first control is an on/off control.

8. A user interface according to any one of the preceding claims wherein a first of the controls is an on/off control and the appliance is arranged, in response to a user operating the first control, to connect a processor in the appliance to the power source.

9. A user interface according to claim 8 wherein the processor is arranged to perform a check before illuminating the second of the controls.

10. A user interface according to any one of the preceding claims wherein the final control, in the order of operation, is a start control for the appliance.

11. A user interface according to any one of the preceding claims wherein one of the controls offers a selection of speed of operation of the appliance.

12. A user interface according to any one of the preceding claims for a robotic floor cleaning device having a brush bar wherein one of the controls offers a selection of using a brush bar on the device.

13. A user interface according to any one of the preceding claims, wherein at least one of the user-operated controls comprises a plurality of buttons, each button having an indicator closely visibly associated with it, the buttons representing choices for a feature of the appliance.

14. A user interface according to any one of the preceding claims, wherein each control indicator is located on the respective control.

15. A user interface according to any one of the preceding claims wherein the controls are physically arranged in the order that they are operated.

16. A robotic appliance including a user interface according to any one of the preceding claims.

17. A method of operating a user interface for a robotic appliance, the interface comprising a plurality of grouped user-operable controls by which a user can control the appliance, each control having a respective indicator closely visibly associated with it, each control indicator being capable of taking three different visible states, the visible states being (a) an off state indicative that the associated control is not available for selection, (b) an invitation to operate state indicative that the associated control is available for selection and (c) a selected state indicative of the associated control having been selected, the method comprising:

- illuminating one of the control indicators in visible state (b);

- determining when a user operates that control, changing the visible state of the control indicator to visible state (c) and illuminating another of the control indicators in visible state (b) whereby to indicate a change in the state of readiness-for-use of the appliance.

18. An appliance substantially as described herein with reference to the accompanying drawings.

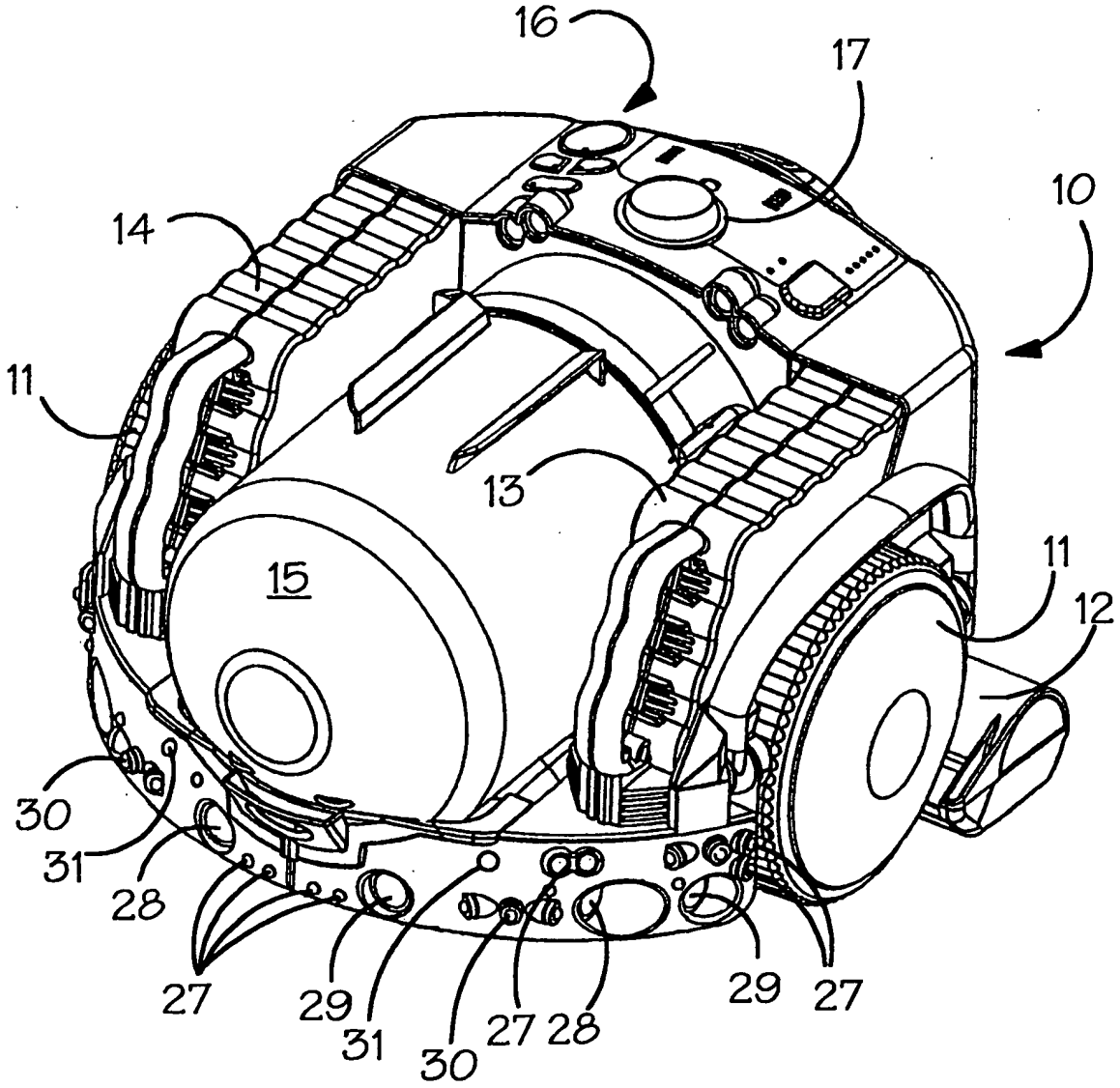


FIG.1.

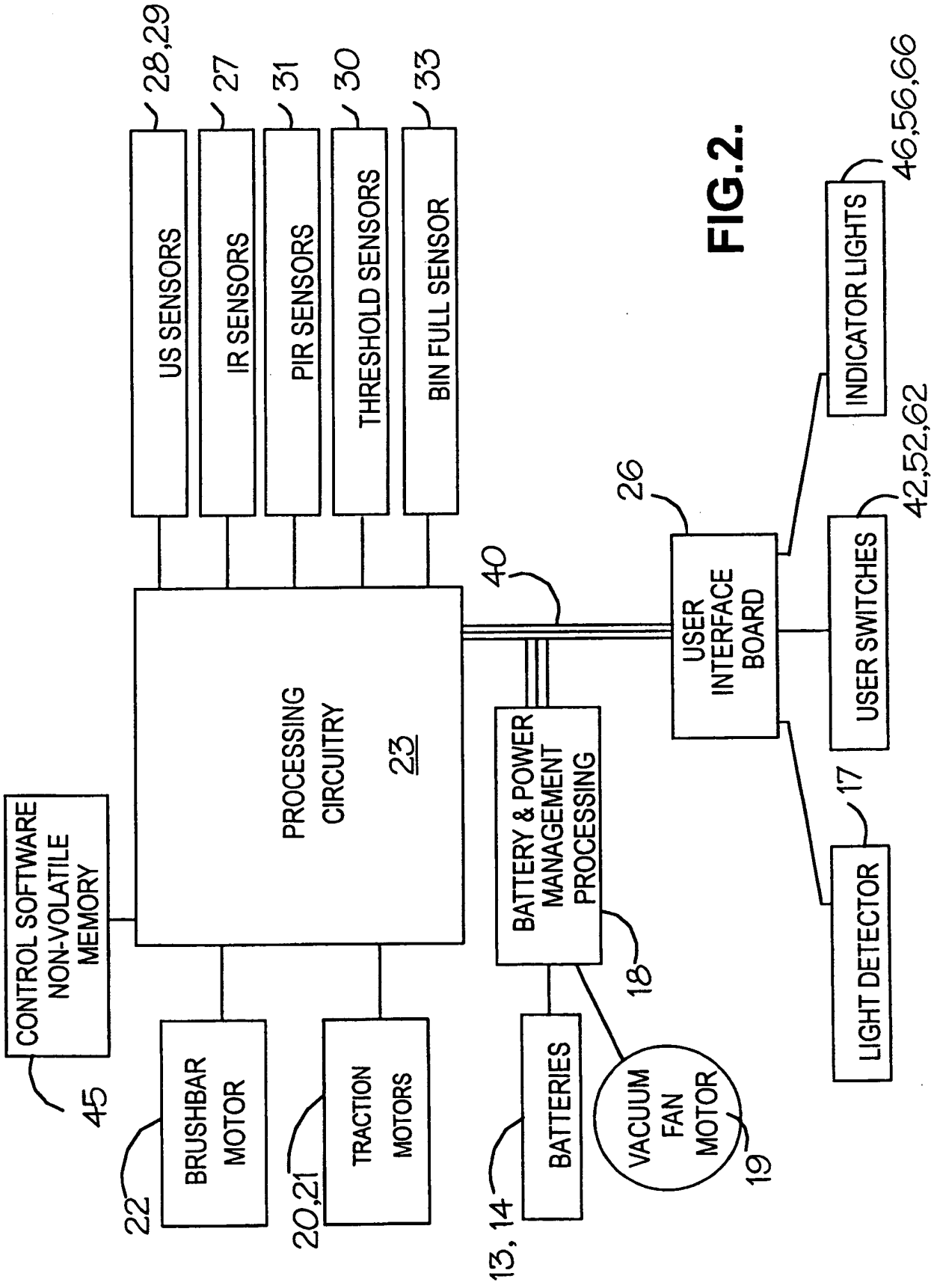

28,29
US SENSORS
27
IR SENSORS
31
PIR SENSORS
30
THRESHOLD SENSORS
33
BIN FULL SENSOR
46,56,66
INDICATOR LIGHTS
42,52,62
USER SWITCHES
17
LIGHT DETECTOR
26
USER INTERFACE BOARD
40
PROCESSING CIRCUITRY
23
BATTERY & POWER MANAGEMENT PROCESSING
18
CONTROL SOFTWARE NON-VOLATILE MEMORY
45
BRUSHBAR MOTOR
22
TRACTION MOTORS
20,21
BATTERIES
13, 14
VACUUM FAN MOTOR
19

FIG.2.

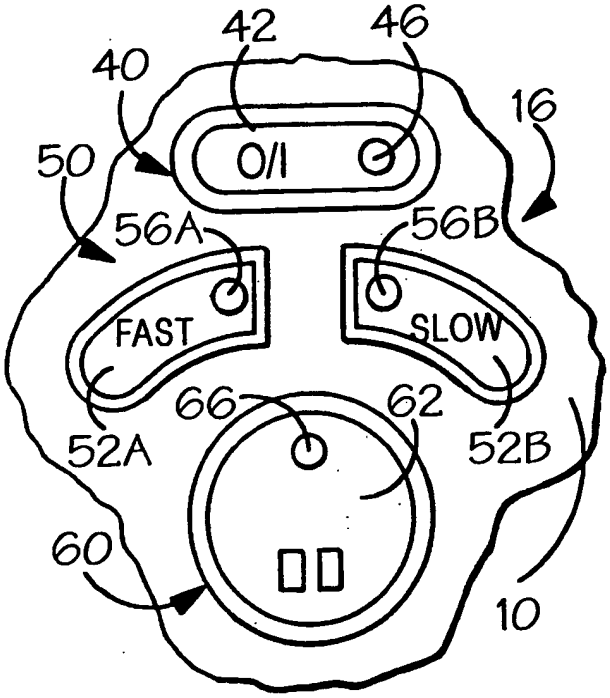

42
46
40
16
50
O/I
56A
56B
FAST
SLOW
66
62
52A
52B
60
10

FIG.3.

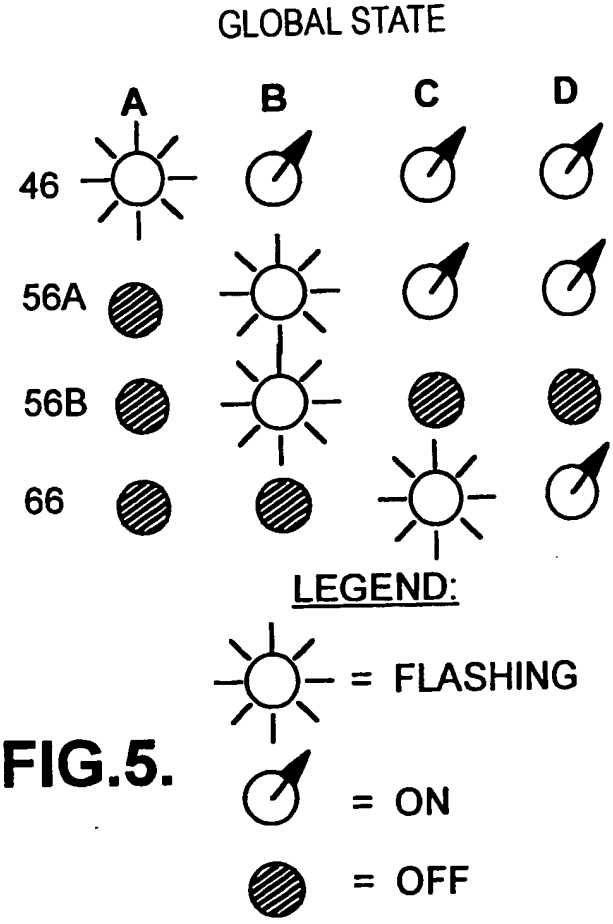
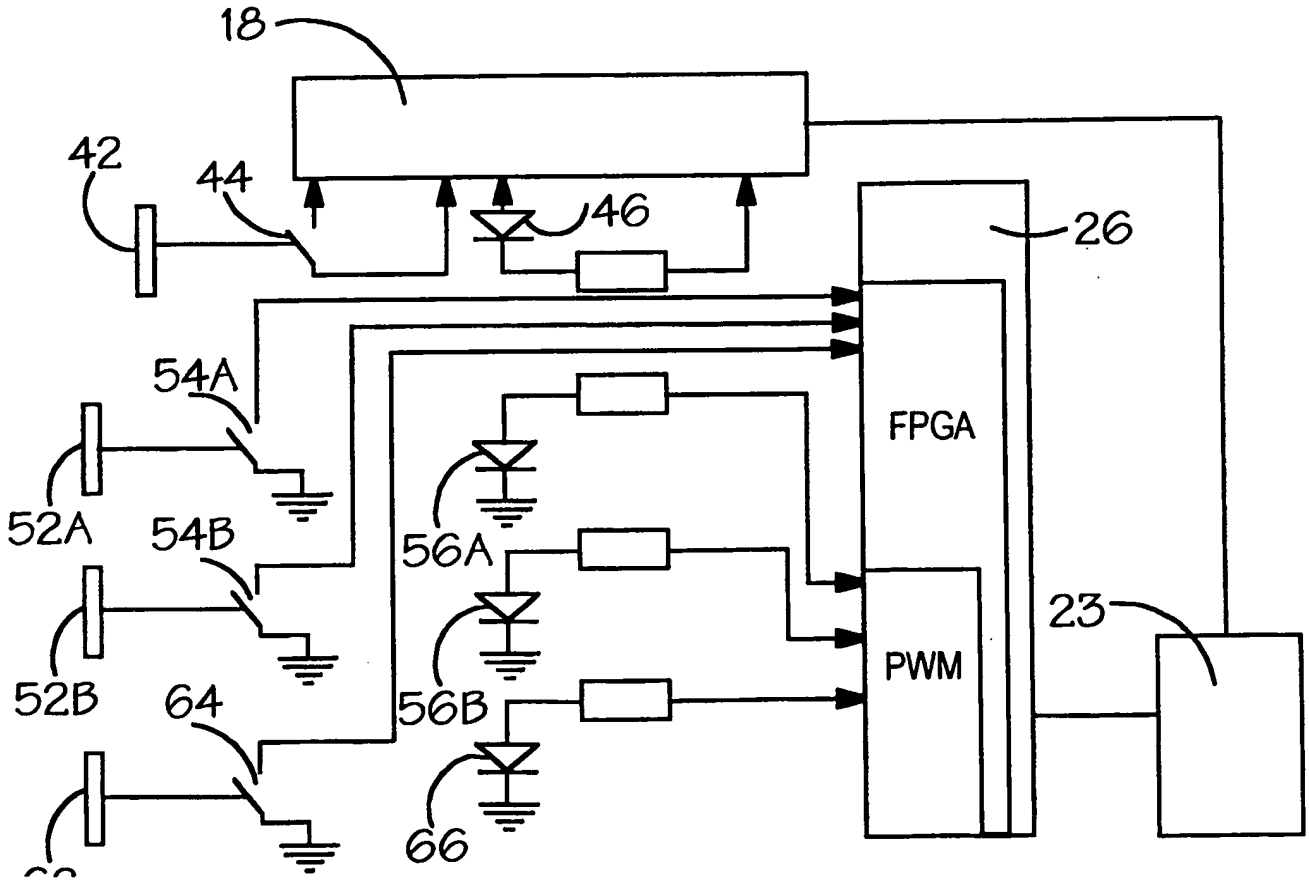

GLOBAL STATE
A
B
C
D
46
56A
56B
66
LEGEND:
= FLASHING
= ON
= OFF

FIG.5.


18
42
44
46
26
54A
FPGA
52A
54B
56A
PWM
23
52B
64
56B
66

INTERNATIONAL SEARCH REPORT

Im ational Application No
PCT/GB 00/02370

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G05B19/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G05B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 279 672 A (BETKER MARK ET AL) 18 January 1994 (1994-01-18) the whole document ---	1-18
A	DE 43 35 990 A (VAILLANT JOH GMBH & CO) 28 April 1994 (1994-04-28) the whole document ---	1,17
A	DE 39 10 845 A (ABB PETERCEM) 11 October 1990 (1990-10-11) the whole document ---	1,17
A	US 4 454 596 A (LEZIUS ALBRECHT ET AL) 12 June 1984 (1984-06-12) the whole document --- -/--	1,17

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
19 October 2000	26/10/2000
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2	Authorized officer

INTERNATIONAL SEARCH REPORT

Im. .ational Application No
PCT/GB 00/02370

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 756 218 A (SEIKO EPSON CORP) 29 January 1997 (1997-01-29) the whole document -----	1,17

INTERNATIONAL SEARCH REPORT

Information on patent family members

In. .ational Application No
PCT/GB 00/02370

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